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ABSTRACT

Analysis of behaviorally expressed instructional objectives, materials, and criterion test items in reading has generated a finite list of operations and conditions that cover almost all possible reading activities and behaviors. The list has been organized into a short, simple Code Key. A 15-cell computerized syntax has been designed to carry the list members in combinations and sequences, generating a coded statement for every possible reading behavior and a concomitant literal translation. This system, Systems Coding Analysis (SCAN), automatically matches any set of behavioral statements coded into SCAN language. Thus, activities, instructional materials, expressed objectives, test items, or recorded observations can be automatically stored and matched by a computer. This system allows us to analyze the learning-to-read process in depth and it provides curriculum information that directly affects classroom instruction. (Author)

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SCAN: COMPUTERIZED ANALYSIS OF READING BEHAVIORS

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INTRODUCTION

Behaviorally defined instructional objectives (I-O's) are not simply a passing fad, but whether or not they will make a difference in the quality and quantity of instruction in the schoolroom is an issue separate from the permanence of their existence. Publishers of tests and instructional materials will decide that issue, for they are the real powers behind curriculum. On the one hand, publishers may simply decide to express their scope and sequences in I-O language, in which case, I-O's will have the same effect as those dubious scope and sequences. On the other hand, publishers could take I-O's seriously and design materials and assessment tools consonant with operationally defined I-O's. Considering the earliest signs from the profit makers, we predict the former rather than the latter. Tying together a clearly stated operational goal, a method of assessing that precise operation under specified conditions, and a set of materials that purport to bring about that goal is the kind of accountability publishers would not dare risk. Why should they? Their professional customers are not willing to risk it either.

THE NEED FOR SCAN

Any hope of basing curriculum on an I-O system depends first upon political-economic factors and only secondarily upon substantive educational factors. If a quirk of fate swings the pendulum toward an I-O based curriculum, the substantive educational factors will hinge

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on a method of tying together each operationally defined instructional objective with a criterion assessment item or observation, with a set of specific instructional prescriptions (materials and strategies).

This paper describes such a method, Systems Coding Analysis (SCAN), designed by the authors under a research and development contract between the State Education Department of New York (SED), and Random House Educational Systems Division working with staff of the Reading and Language Arts Center of Yeshiva University's graduate school.

SCAN was designed to generate an instructional objectives bank in reading for a criterion performance assessment program under development by Dr. Robert O'Reilly of SED's Bureau of Educational and Cultural Research. The I-O's in the SED bank had to:

1. Include most of the behaviors that need to be taught to help children learn to read.
2. Be behaviorally specific.

At the present time, no existing I-O bank in reading meets these two criteria. Many existing banks include I-O's that are behaviorally specific but do not exclude automatically non behavioral I-O's. Certainly, no existing I-O bank in reading is all-inclusive.

The Systems Coding Analysis (SCAN) gives an I-O bank the technology for meeting the first criterion. SCAN allows every existing I-O in reading to be checked against SED's I-O bank, or any I-O bank stored in SCAN language. In effect, SCAN allows us to express in computerized language every possible reading behavior a person could perform. In addition, SCAN gives a computer the ability to generate automatically every possible reading behavior that a person could perform. Finally, SCAN

guarantees that the expressed I-O will be behavioral.

A DESCRIPTION OF SCAN

In very practical terms, SCAN allows an analyst to use a computer to match any observed reading behavior, reading test item, instructional material or existing stated I-O with each other. Figure A presents a behavioral statement that we call a "Generic Objective" (G-O), which is a type of I-O.* The G-O (or I-O, or behavioral description) expressed in standard English is called an "Expressed" G-O. Figure A first presents the Expressed G-O and then presents a chart with the SCAN code number for each concept in the Expressed G-O and the Literal Translation of each SCAN code number.

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* A G-O is a behavioral statement describing a basic operation in reading. It includes key conditions under which the basic operation is performed, but it excludes certain variant conditions and the specified criterion level of acceptance.

Figure A

EXAMPLE OF AN EXPRESSED G-O TRANSLATED INTO SCAN NUMBERS AND LITERAL TRANSLATION

Expressed G-O: Given visually an incomplete word, the student designates the missing final consonant digraph.

SCAN SYSTEM

Code →	02	010	003	000	103	122	000
Lit. Trans.→	Visual	One	Word		Complete	Not	
Code →	01	03	010	000	002	002	037	000
Lit. Trans.→	Designate*	Kinesthetic	One		Consonant Digraph	Final	Missing	

*The Term "designate" in SCAN has a technical meaning: to slash, cross out, underline, circle, press, or insert the appropriate visual symbol from a number of alternatives. Therefore, a G-O with a designate "operation" automatically denotes input condition: "and given a list of X's from which to select one or more correct responses."

In Figure A, the first chart is the SCAN expression of input conditions ("Given visually an incomplete word..."). The second chart is the SCAN expression of the learner's operation and implied output conditions ("...student designates ((crosses out, slashes, etc.)) the one ((of a set of distractors)) missing final consonant digraph).

The SCAN code allows for four input conditions, four output conditions and four learner operations. In Figure A, seven coded cells designate input conditions: In the first cell, 02 represents "visual" output; in the second cell, 010 represents the numeral "one;" in the third cell, 003 represents "word" and so on for the seven input cells. SCAN accomodates four sets of these seven input cells. Thus an I-O that reads: "Given W, and given X, and given Y, and given Z, the student...." can be accomodated.

On the second line, the 01 in the first cell represents "designate," a technical term for a specific kind of operation and seven other cells describing output conditions. Again, SCAN provides for a maximum of four sets of these output and operations cells.

Figure B explains the grammar by listing what each cell represents.

Figure C puts the contents of Figures A and B together allowing the reader to see the SCAN grammar and its application to the sample G-O.

Figure B

EXPLANATION OF CELL SEQUENCE IN AN I-O CODED INTO SCAN

Sequence	SCAN Category	Explanation or Example	
Cell 1	Mode (How)	Stimulus input, e.g., visual	Input
Cell 2	How Many	Number of stimuli, e.g., one	
Cell 3	What Given	Kind of thing (primary classification), e.g., word	
Cell 4	Component	Subclassification of thing, e.g., consonant digraph	
Cell 5	Modifier	Delimits subclassification and/or primary classification, e.g., final, missing	
Cell 6	Modifier		
Cell 7	Modifier		
Cell 8	Indicator	The observable behavior of the student	Operation
Cell 9	Mode (How)	Same as Cells 1-7 respectively	Output
Cell 10	How Many		
Cell 11	What Given		
Cell 12	Component		
Cell 13	Modifier		
Cell 14	Modifier		
Cell 15	Modifier		

Figure C

DESCRIPTION OF SCAN SYNTAX WHICH IS DETERMINED BY CELL SEQUENCE

CODE NUMBER	02	010	003	000	101	122	000
LITERAL TRANSLATION	Visual	One	Word		Complete	Not	
CELL NUMBER & LABEL	1 (Mode)	2 (How Many)	3 (What Given)	4 (Component)	5 (Modifier)*	6 (Modifier)	7 (Modifier)

CODE NUMBER	01	03	010	000	002	002	037	000
LITERAL TRANSLATION	Designate	Kines-thetic	One		Consonant Digraph	Final	Missing	
CELL NUMBER & LABEL	8 (Indicator)	9 (Mode)	10 (How Many)	11 (What Given)	12 (Component)	13 (Modifier)	14 (Modifier)	15 (Modifier)

*Modifiers are coded in reverse sequence of standard syntactical order.

HOW TO USE SCAN

SCAN requires the use of one of two Code Keys. The Code Keys simply allow a Literal Translation from SCAN numbers to Literal Translation or from Literal Translation to SCAN number. The former is useful when G-O's in SCAN form are retrieved from a computer bank for research and development purposes. The latter Code Key allows us to SCAN code an I-O, or an observed behavior, or a criterion test item, or an instructional materials analysis. The coding or decoding is done on a worksheet laid out by cells similar to the charts in Figures A and C or on computer worksheets for transfer to punch card or OCR form.

The Literal Translation is the Code Key equivalent of each number and is used for coding purposes for analysis, retrieval and research. In translating an Expressed I-O into SCAN, the translator finds the Literal Translation equivalent of the expressed I-O term in a SCAN Code Key. He records the SCAN number in the appropriate cell on a worksheet. A cell is a space for a one, two or three-digit code number that represents a term in an Expressed I-O. For example, an expressed I-O may begin: "Given a printed word..." The SCAN number for "word" is 003. "Printed word" implies that the word is presented visually. The SCAN number for the mode known as "visually" is 02. The sequence of the SCAN code number determines the syntax of an Expressed I-O. Figure B explained that syntax.

THE CODE KEYS

The Code Keys are, themselves, a revealing analysis of the components of reading behavior. For example, input and output behaviors can manifest themselves in eight modes (SCAN coded 01 to 08): oral, visual, kinesthetic, any combination of these modes, plus a mode we call "from memory." "From memory" serves to indicate those conditions under which a stimulus had been presented previously at some distance in time from the desired operation.

The SCAN Code Key term for operation -- the action performed -- is called "Indicator." SCAN finds that 31 different Indicators can express almost all the reading operations that a person can perform.

The SCAN Code Key finds that 53 different "givens" cover just about all the possible presenting stimuli in a reading situation. In Figures A,B or C this is expressed as "What Given" in Cell 3. For example:

"Given a book...."
"Given a chart...."
"Given a thesaurus...."
etc.

This surprisingly small number of Givens is augmented considerably by another list of subclasses of Givens called "Components" (Cell 4 in Figures A,B and C). Thus, a map (SCAN Code Number 41 which would appear in Cell 3) might be augmented by key (SCAN Code Number 331 which would appear in Cell 4) indicating that the reader is presented a "key to a map." There are 378 such Components.

Only 196 modifiers round out the key. Thus, all reading behaviors can be operationally described by eight Modes, 31 Indicators, 53 Givens, 378 Components and 196 Modifiers. In combination within the SCAN syntax (cell order), these 658 terms account for just about all reading behaviors.

USES OF SCAN

SCAN allows us:

1. To store any I-O in a computer bank.
2. To match any I-O to an existing I-O bank. For example, by coding a newly proposed I-O into SCAN numbers, the proposed I-O can be matched to the bank to see if the I-O is already catalogued.
3. To avoid duplication. With thousands of I-O's in a bank, this system avoids duplication. The process of expanding the bank is speeded up as staff members can easily ascertain if an I-O is already catalogued.
4. To avoid the ambiguities of regular language; i.e. to increase behavioral specificity. Are two I-O's really different? Or are they behaviorally the same when "regular" language is analyzed behaviorally into SCAN. This insures greater behavioral specificity in the I-O.
5. To create new I-O's. A computer can be made to produce behavioral descriptions of reading by generating combinations and permutations of SCAN code number cells.
6. To code instructional materials, criterion-referenced performance items and standardized test items into their appropriate I-O's. By expressing the test item or instructional activity in SCAN language, the appropriate I-O is instantaneously retrieved and matched to the criterion item or to the instructional prescription. If an I-O is not retrieved, the instructional activity or test item coded into SCAN becomes an I-O with its own ready-made prescription or criterion item.
7. To pinpoint the need for new materials for which G-O's and reading behaviors exist, but for which, according to the SCAN coded materials bank, no or few materials exist.
8. To research the kinds of behaviors and qualities that make up the reading process. The search for behavioral substrata of reading has been stymied

by the failure of existing research models to answer the kinds of questions that reveal what reading "really is." An assessment system that collects data over the years on I-O's that are retrievable in SCAN terms by cell or cell combinations will help reveal that elusive substrata.

CONCLUSION

Some of these uses generate dramatic implications for American reading instruction.

Designing an instructional objectives bank in reading involves tremendous effort and technical complexities. So, it is most discouraging to travel from one school to another witnessing huge sums of money and human resources expended on the "reinvention of the wheel." SCAN demonstrates that a finite list of reading behaviors exists and that many differences from one I-O bank to the next are operationally irrelevant. Most of these differences involve variations in language because of the imprecision of standard English. SCAN makes possible a centrally located I-O "super" bank that bypasses this imprecision of language and eliminates duplication. A centrally located, publically operated, national SCAN I-O bank in reading would be able to store every I-O in existence without duplication. It would be able to correlate with every I-O any criterion performance item. And with very little cost, a SCAN operated national I-O bank could maintain an item by item, page for page correlation of every published instructional program in reading with each I-O and each criterion test item. All of this in any combination could be linked to every school system in the country at very little cost.

If the bank were to provide criterion performance assessment items for each I-O, and if the results of these assessments were fed back to the bank, SCAN would allow us to pinpoint the behavioral substrata of reading, for the SCAN code provides for every possible condition and operation in the reading process.

In the short run, the first implication would make a huge difference in our Right to Read efforts. In the long run the second implication could open a whole new approach to behavioral research in reading.